SPECIAL COMMUNICATION

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Scientific Certainty: Research Versus Forensic Perspectives

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ABSTRACT: The scientific community and the judicial system are different components of society with different structures and functions. Nevertheless, science can contribute relevant and useful information to judicial deliberations if the inherent limitations of that information are understood. These limitations stem from the way the information is presented and perceived both by those who are providing it and those who are providing the context in which it is presented.

KEYWORDS: forensic science, conflict of interest, deception, ethics, expert witness, research, scientific certainty

The scientific community is a part of society, not a thing apart from it. The work of science professionals has the potential for making important, even critical, contributions to various societal structures and systems, including the judicial system. A positive contribution is not, however, likely to be automatic. Rather, the context in which findings are developed, and the context in which they will be used, need to be compared in order to assess limitations and the potential for application as well as misapplication.

How scientific findings are presented and perceived (or misrepresented or misperceived) has serious, even profound implications. These implications can differ in important ways depending upon the context (for example, the background and expectations of the audience). Equally critical is the purpose in reporting the findings and how they are characterized. An important example is the notion of "certainty." The concept of "scientific certainty" in the research setting and in the courtroom has different, potentially competing or conflicting meanings and functions. Ethical issues are inherent in the differing roles of researchers and engineers in these two settings because there is the potential for miscommunication even while it is well understood that clear and accurate communication can be crucial. In fact, in the courtroom, miscommunication may have irreversible life and death consequences. Differing roles and perceptions have ramifications for attorneys, engineering and scientific experts, the judicial system, and for society.

Potential conflicts arise primarily because of systemic differences between the two environments. While the scientific and research communities are both in search of truth, the scientific community has the luxury of time. In the courtroom, guilt or innocence is to be determined expeditiously in spite of uncertainty. In the research setting it is expected that understanding of a phenomenon will be revealed bit by bit over time.

The structure and function of these two environments also differ. Research is essentially a collaborative process where individuals work on various facets of a problem, each contributing to understanding the whole.[2] However, the judicial system is adversarial with the participants arrayed as teams opposing each other. These differences in the fundamental nature of the two settings are reflected in the relationships between, and the resulting ethical responsibilities of, those involved.

This highlights the fact that the use of scientific information can raise ethical concerns. Most obviously there is the possibility of deception as a result of the intentional—or unintentional but foreseeable—misrepresentation or misapprehension of the information or its context. In addition, there is the potential for conflicting interests which raise ethical concerns when concurrent roles and responsibilities clash. As a result, there is the possibility of misrepresentation or misapprehension of how the information ought to be weighted.

Research Findings in the Scientific Community

In scientific research, investigators explore the natural world in a systematic and organized way (at least theoretically). In actuality, of course, scientific investigation is not quite so well-organized and planned: there are frequently serendipitous discoveries; luck often plays a significant role; and intuition that reflects conscious and unconscious habits of mind built on years of training and education, is critical (1). Researchers build on their own previous work as well as on the work of others. They understand science as an ever-evolving body of knowledge, and recognize that scientific concepts may be reshaped in light of new findings.

The certainty that is expressed in the publication and public presentation of research results is also acknowledged as subject to change, potentially to be superseded by additional, perhaps contra-

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[2] Some would say that research is, and ought to be, a competitive process, like a race or a golf match rather than a collaborative one like a construction team. But even when researchers are competitors, participants are independent actors, not opponents.

dictory, findings. Thus, in the research setting, the notion of "scientific certainty" is extremely limited, akin to "reliable" and "reproducible". It is substantially reduced from the concept, and expectations, of "certainty" that are often held by the populace at large. It is, rather, a snapshot in time, a puzzle piece whose meaning may change as more pieces of the puzzle are revealed, an evaluation based on a particular assessment of the relevant variables and an appreciation of the data in the context of what is currently known about the field and the research problem. For example, early on it was thought that the function of the brain was to cool the blood and that the heart was the center of thought and the seat of the soul. With further information, our understanding of human physiology has changed considerably, and will no doubt continue to evolve.

Because researchers typically build on previous work, they depend upon the integrity of their colleagues and collaborators, and upon the reliability of the published literature in order to justify the investment of time, effort, research dollars, and potentially scarce resources of various kinds including supplies, personnel, and research subjects. Given the interdependence of the scientific community, it is not surprising that honesty and integrity are core values and that there is universal agreement that fabrication or falsification of data is considered scientific misconduct and an egregious ethical breach.

Misrepresentation of research findings can also arise from the inadequate disclosure of the limitations of research methods or results. In addition, although it is expected by researchers, their colleagues, and the public, that data analysis, interpretation, and presentation will not be inappropriately influenced by various outside interests, it has come to be recognized that a wide variety of factors can consciously and unconsciously affect both research conduct and the reporting of research results (2,3). Personal, professional, or financial factors that introduce political, social, religious, or other bias, can skew results inappropriately.

Bias is neither necessarily inappropriate nor synonymous with prejudice. Indeed it is sometimes justifiable. For example, one may have a bias in favor of opinions supported by clearly articulated, internally consistent data. However, justifiable or not, biases are not generally acknowledged let alone justified. As a result, their justifiability goes unexamined.

Recognizing the possibility that inappropriate unconscious, or even conscious bias may influence research findings, researchers generally maintain, to a greater or lesser degree, a healthy skepticism regarding the work of others (4). They expect that the accretion of evidence over time will confirm or modify generally accepted scientific concepts and overcome inappropriate bias.

In science the boundary conditions and context are generally stated. The research community's quality control efforts are aimed at clarifying the limitations or problems in sample selection, data collection, analysis, and methods, as well as any ambiguities, confounding anomalies, or other problems with research findings. This is in an effort to prevent other researchers from inappropriately relying upon the work of others. Another concern is that research claims do not overreach the data (5,6).

Peer review is generally considered the tool of choice to ensure the quality and integrity of published research findings, but it is not without its own limitations. Reviewers do not generally have access to the original data, may themselves be biased or have conflicts of interest, and usually operate under time and/or knowledge constraints. Moreover, editors who oversee the assignment of papers to reviewers themselves have biases and limitations. Ultimately editors must rely on their own subjective judgement in interpreting and weighing reviewer's comments, and in making recommendations to authors and acceptance decisions. Thus, peer review should not be allowed to create a false sense of security regarding the pristine quality of scientific findings. The scientific literature is littered with errata that provide corrections to papers that have passed through the peer review process. These are likely to be only the most obvious tip of the iceberg of peer review fallibility.

Scientific Findings in the Courtroom

The courtroom presentation of scientific findings is fundamentally different from presentation in the research arena. In the courtroom, the role of scientific evidence is to provide information, "facts," that bear upon the circumstances of a particular case. The judge or jury must extrapolate to a greater or lesser degree from these facts to determine guilt or innocence, responsibility, liability, and, when finding liability, damages. Expert testimony is allowed to assist triers of fact in understanding and evaluating the evidence when those facts would not normally be within their knowledge and experience.

The nonprofessional public seems to believe that scientific information presented is "neutral," contributing directly to the matter in dispute as an element of "truth" that would help assure that justice is done. However, in actuality, it should be recognized that opposing counsel must each put the matter in its best light for those they represent so that the trier of fact can decide where truth and justice lie. Expert testimony is but one component of the case developed by one side or the other. For this reason, in-the-courtroom, up-front disclosures by a witness of limitations of any engineering and scientific work are abhorrent to the retaining attorney. In the forensic arena, it is the function of the opposing counsel to ferret out any limitations in research method or scope. It is considered a plus if opposing counsel should fumble or miss that opportunity.

Consider, as an example, the way that scientific information is dealt with by opposing counsel in the use of DNA fingerprinting to identify an individual. It carries with it ever-increasing respect for the sophistication of recombinant DNA technology and implicit in its credibility is an appreciation of the relatively unique genetic makeup of each person. At the same time, well over 90% of the human genetic code is identical to that of nonhuman primates. Naturally the shared genetic code of even distantly-related human beings will be considerably greater. Uniqueness is confined to a small percentage of discrete segments of DNA. Moreover, laboratory techniques that are capable of amplifying a minuscule, untestable sample in order to provide an amount of DNA on which testing can be carried out, are equally capable of amplifying contaminant DNA.

In a particular case a prosecutor might focus on, and emphasize, unique DNA sequences that can accurately and reliably identify a specific individual. Defending counsel, on the other hand, would rightly highlight the critical importance of procedures for sample collection and handling, the chain of custody of the sample, and the potential for, and implications of, contamination. In short, in the judicial arena, there is no sense of collaboration, but rather a "winner-takes-all" mind set.

The Researcher in the Courtroom

Researchers generally have the same misconceptions regarding the nature and function of the justice system as do members of society at large. The researcher considers her or himself to be a forensic scientist first, with knowledge and expertise of relevance to a particular case, in other words an EXPERT witness. In actuality he or she is an instrument of the retaining attorney and the courts, i.e., an expert WITNESS. Thus, what scientific colleagues expect of each other as a matter of professional and personal integrity, that is, voluntary, full disclosure of the limits of methods and results, is not expected or even necessarily desired by any of the players in the courtroom.

It could also be argued that experts have a responsibility not only to be accurate, but also to make sure that they convey information. This is a dynamic process between speaker and listener. The speaker has a responsibility to attend to the responses of the listener in order to discern whether communication is happening. The greater the import of the information, the greater the responsibility of the speaker. Yet what is important for the legitimate expert to include ethically might not be possible given the procedures of the judicial system.

In the judicial system, the only surrogates for the peer-review process are: (1) the critique of the expert's analysis and results by the expert(s) retained by the adverse parties (which may be close to impossible in those venues where expert disclosure is limited, e.g., by rule of court, rule of evidence, or lack of resources of the adverse party) and (2) the use of previous trial and deposition testimony to impeach those experts who contradict themselves either because they are unscrupulous, because legitimate scientific opinion has changed over time, or because the circumstances of prior proceedings were different. Both defense and prosecution or plaintiff may expect, and may pressure, "their" expert not simply to present but to put a spin on the scientific information to favor the case being presented by whomever is paying the expert's fee. Moreover, the witness may feel inclined to tailor presentation and testimony to the needs of the retaining party in hopes of future employment (which is clearly unethical) or for other conscious or unconscious motives. As discussed above, a number of factors, including political, social, personal, and professional bias can affect technical analysis and professional decisions (2,7,8).

One solution is to have expert witnesses who advise the court directly, either instead of, or in addition to, those hired by the two opposing counsel. However, because of the fundamental adversarial nature of the judicial system, there is the concern (9) that the view of court-appointed experts who are independent of either of the opposing sides, may be given overriding weight because of their seeming lack of vested interest. Moreover, court-appointed experts may create a false sense of security that bias has been eliminated. Yet even forensic scientists appointed by the court are likely to bring potentially inappropriate, conscious or unconscious personal and/or professional biases and limitations to the presentation and weighing of research results.

At the other end of the continuum from the research scientist, is the "professional opinion" provided by contract consulting firms. This opinion is presented in full recognition of the adversarial nature of the judicial system and of the role of the witness as a participant on one side or the other. The potential for deception based on misrepresentation or misapprehension of the purpose of the testimony is much reduced since the role and motivation of the witness are explicit. The witness clearly understands where his or her loyalty belongs. However, the firm, and the witness, have an interest in maintaining their professional reputation which rests in the quality of the professional opinion itself. Thus, the trier of fact may inappropriately undervalue the professional opinion of a contract forensic consulting firm because of a vested interest that may be more apparent than real.

Scientific Certainty in the Courtroom

As in the development of public policy, the judicial system attempts to meld facts and societal values, that is, it attempts to weigh facts in the larger context of the goals, expectations, and standards of society. It is entirely appropriate to include relevant scientific facts and information in deliberations. At the same time, the judicial system is designed to respond to the need for decision making, even in the face of uncertainty. Recognition of the range of possibilities is reflected in the various standards of proof from "more likely than not" to "by a preponderance of the evidence" to "clear and convincing" to "beyond a reasonable doubt." Insidious and harmful distortions are created if information is presented or perceived as both accurate and value-free when in actuality it is of limited reliability and reflects unacknowledged and irrelevant bias. The situation is even more problematic if the information is given undue weight precisely *because* its limitations and inherent values are unrecognized.

There is no easy answer. In the courtroom, as in the laboratory, scientific certainty is one individual's best evaluation of a given issue at a particular moment in time. The label expresses a willingness to place information in a relatively arbitrary category. Yet scientific testimony delivered by forensic scientists may carry undue weight to the extent that it is perceived by the triers of fact as unbiased truth coming from a highly educated and unimpeachable source. In fact the ethical code of the American Academy of Forensic Sciences (AAFS) acknowledges this possibility when it admonishes members neither to misrepresent their credentials or expertise, nor to overreach the data and draw unwarranted conclusions. Furthermore, expert testimony by a scientist or engineer may have more immediate, apparent, serious, and potentially immutable (or at least far longer-term) consequences than the presentation of research results to the research community.

As indicated above, forensic scientists are, by education and training, usually scientists first, steeped in the culture of science. They often regard scientific investigation as a search for the truth, and generally bring their knowledge and expertise to the judicial system with the expectation that they can provide information that will shed light on a problem and contribute to justice. The ethical "rub" arises in the clash of cultures that undermines this expectation. Research findings can be richly nuanced and not easily adapted to the "yes-or-no" adversarial climate of the courtroom. The way in which opposing attorneys frame and reframe scientific findings through the use of the hypothetical and cross, redirect, and recross examination can illuminate, but can also shade, color, or even distort the context and thereby the perception of the information presented. Moreover, the research and nonresearch communities are likely to talk past each other without adequately appreciating or even necessarily recognizing the fact of—let alone the extent of—their miscommunication (10). This compounds the probability of, and the problem created by, their miscommunication. This miscommunication is of particular concern for experts who provide testimony they expect will be understood and used only as appropriate.

Disconcerting and potentially hazardous for the expert witness are the perfectly legal and appropriate strategies and tactics of attorneys. Hiring attorneys may manipulate the expert to say what (s)he may not mean, and opposing counsel may attack the credibility of the expert (e.g., by questioning his or her mental stability) in order to undermine the expert's testimony and assist the client.

Conclusion

The judicial system seeks truth as a part of the means to obtaining justice. The scientific community seeks truth as a component of knowledge. Although they both seek "the truth", in some fundamental ways, the judicial system and the scientific community differ with regard to underlying function, values, and goals. Forensic scientists and the triers of fact need to recognize these differences in order to make the contribution of science to the judicial system optimal.

Expert witnesses need to recognize, assess, and acknowledge unconscious as well as intentional personal and professional biases in order to maintain personal integrity in a setting that may value them more as team players than as individual actors. Officers of the court, and especially triers of fact, need to understand value differences that can lead to differences in the notion of "scientific certainty" in the scientific community and in the courtroom, and therefore how the term is used and understood. The difference in the way in which the research and the forensic communities perceive engineers and scientists, and research results and their limitations, can create significant conceptual and ethical dilemmas for anyone with one foot in each community.

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